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The Residual Toxicity of Some Newer Acaricides to the Two-Spotted Spider Mite (Acarina: Tetranychidae)¹

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The data presented in this paper were obtained during preliminary tests of acaricides that have been carried on in the greenhouse since 1947. Special attention has been given to the duration of residual action because this is one of the most critical indications of the potential value of an acaricide under field conditions. Residual toxicity in these experiments may be defined as the toxicity of a dry deposit to mites introduced on foliage subsequent to spraying.

The modes of action of the various acaricides are uncertain. In most cases it is undoubtedly contact action, although the more volatile materials may have some fumigant effect. Toxicity by direct ingestion is unlikely because of the feeding habits of the mites, but it is possible that some of the compounds tested may have a systemic action, being absorbed by the plant and remaining within the tissues for an extended period.

Methods

The two-spotted spider mite, *Tetranychus bimaculatus* Harvey, was reared on the scarlet runner bean, *Phaseolus coccineus* L. For the purposes of the investigation this is much superior to varieties of the common bean, *Phaseolus vulgaris* L., because the primary leaves are very large and firm and remain in good condition a long time if the central shoot is pinched out. It also lacks the stellate hairs that are found on other beans, and that often entrap appreciable numbers of mites. The seeds were sown thickly in eight-inch flower pot saucers, and transplanted singly to three-inch pots when the first leaves were opening. They were used for the tests as soon as the primary leaves were full-grown.

The sprays were applied with a DeVilbiss motor-driven compressed-air paint sprayer with a nozzle that produced a fine, even spray under an air pressure of approximately 20 lb. The plants were thoroughly sprayed from all sides to the point of run-off. A suitable amount of spreading agent, usually Orvus (32 per cent sodium lauryl sulphate) at 0.25-0.4 lb. per 100 gal., was added to provide even coverage.

In the tests on each material, a number of uninfested plants were sprayed at one time, and at intervals over a period of 14 days (20 days in one instance) mites were introduced on a succession of these plants by placing pieces of heavily infested leaves upon them, two plants being used in each test. After 24 hours the active mites had moved onto the plant and the pieces of leaves were removed. Mortality records were taken seven, 14, and sometimes 21 days after the introduction of the mites on the sprayed foliage, by counting living and dead mites under a binocular microscope. Approximately 300 to 500 mites were counted per plant at each examination. All mortality records included not only the introduced mites but also those hatching from eggs deposited on the sprayed foliage. During examinations notes were taken on the relative numbers and condition of the eggs, but the latter were not included in the counts.

Conditions in the greenhouse were maintained as uniform as possible throughout the tests, which were confined to the cooler months, but there was naturally some variation in the temperature, humidity, and amount of sunlight to which

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the plants and their spray deposits and mite populations were exposed. Air currents would vary little, as the greenhouse ventilators were usually closed.

Materials

The formulations used were either wettable powders or emulsifiable solutions as supplied by the manufacturers, except the salts of dinitrocyclohexylphenol, which were prepared in the laboratory. They were generally employed at rates suggested by the makers. A uniform rate or series of rates would have given data more suitable for comparison, but the aim of the experiments was to determine the possibilities of the acaricides for field use where rates are limited by such factors as plant injury and cost. The chemical names of some of the compounds have been altered from those given by the manufacturers to conform with current usage or to demonstrate the relationship between certain materials.

Results

*1, 1-bis-(*p*-chlorophenyl)ethanol (Di-*para*-chlorophenylmethylcarbinol, DMC).*—50 per cent wettable powder. Green Cross Insecticides, Montreal, Que.

The residual toxicity at 0.25 lb. per 100 gal. (50 per cent powder, 0.5 lb.) was very high even after the spray had been on the foliage for at least two weeks, being greater than that of any other material tested except ethyl *p*-nitrophenyl thionobenzene phosphonate. Before the mature female mites succumbed they deposited a few eggs; some of these failed to hatch, and most of the mites from the surviving eggs were destroyed (Table I)..

TABLE I.

Residual Toxicity to the Two-spotted Spider Mite of 1, 1-bis-(*p*-chlorophenyl) ethanol, 50 per cent Powder,
0.5 Lb. per 100 Gal.

Days between spraying and infesting	Total mites examined	Mortality after:	
		7 days	14 days
1	1139	97.2	99.9
2	1055	98.1	100.0
3	1031	96.4	100.0
4	1114	92.7	99.6
5	1055	93.7	99.7
6	1151	95.1	96.2
7	1242	94.1	86.0
10	1200	98.2	99.5
14	1159	89.0	89.4
Check	1115	3.0	3.6

*Bis-(*p*-chlorophenoxy)methane (Neotran).*—40 per cent wettable powder.—Dow Chemical Company, Midland, Mich.

This material at 1.0 lb. per 100 gal. (2.5 lb. of 40 per cent powder) possessed a pronounced residual action, high mortalities of all stages of the mite occurring for about a week after spraying, but after 14 days the mortality was negligible (Table II). Before succumbing, the mites deposited large numbers of eggs; on

spray deposits up to four or five days old these were almost completely destroyed, but on older deposits many hatched and the young survived.

TABLE II
Residual Toxicity to the Two-spotted Spider Mite of
Bis-(*p*-chlorophenoxy) methane, 40 per cent
Powder, 2.5 Lb. per 100 Gal.

Days between spraying and infesting	Total mites examined	Mortality after:		
		7 days	14 days	21 days
1	1717	78.6	86.9	84.7
2	1565	66.9	76.5	66.7
3	1704	68.5	85.4	81.2
4	1761	75.0	88.1	73.1
5	1714	73.9	78.0	61.7
6	1734	81.9	83.4	48.6
7	1707	77.1	93.3	46.7
10	1632	63.6	55.0	43.6
14	1731	11.3	15.7	23.8
Check	1167	5.0	7.7	—

P-chlorophenyl *p*-chlorobenzenesulphonate (C-854).—50 per cent wettable powder. Dow Chemical Company, Midland, Mich.

TABLE III
Residual Toxicity to the Two-spotted Spider Mite of
P-chlorophenyl *p*-chlorobenzenesulphonate, 50 per
cent Powder, 2 Lb. per 100 Gal.

Days between spraying and infesting	Total mites examined	Mortality after:		
		7 days	14 days	21 days
1	1344	77.3	90.3	93.9
2	1129	45.4	84.0	81.1
3	1103	33.6	75.6	83.8
4	1023	65.4	73.8	81.9
5	1217	89.3	87.4	89.1
6	1210	80.4	90.7	85.6
7	1238	62.4	82.8	91.2
10	1301	87.0	91.4	90.2
14	1127	69.1	80.3	85.8
Check	1327	5.6	3.4	2.9

When a mite population was placed on sprayed foliage all forms except the adults were destroyed by this material. Eggs were deposited in very large numbers, but nearly 100 per cent failed to hatch, and practically none of the few young mites that appeared survived. Populations of mites of all stages placed on foliage sprayed up to 14 days previously with one pound actual toxicant (two pounds of 50 per cent powder) and examined after three weeks showed mortalities of approximately 80 to 90 per cent, the survivors for the most part being old mature mites (Table III).

The spraying of established populations of mites showed that the addition of bordeaux mixture to a spray of this acaricide materially increased the mortality of mature mites, and it was also demonstrated that bordeaux mixture did not adversely affect the residual action.

TABLE IV
Residual Ovicultural Toxicity to the Two-spotted Spider Mite of
P-chlorophenyl p-chlorobenzenesulphonate, 50 per
cent Powder, 3 Lb. per 100 Gal.

Days between spraying and infesting	Age of residue on which eggs were laid	Days from spraying to examination	Total eggs laid	Per cent of eggs killed
1	1-5	14	146	91.8
6	6-11	19	261	85.5
10	10-16	23	261	99.2
15	15-20	28	182	86.3
20	20-25	33	180	85.6
24	24-29	37	198	80.9
27	27-32	40	186	78.5
29	29-34	42	51	45.1
31	31-36	44	82	24.4
38	38-43	52	112	16.1
45	45-50	59	40	5.0
Check	-	-	172	7.0
"	-	-	138	5.1
"	-	-	156	23.7

The powerful ovicultural property of this chemical was illustrated by the following experiment. A series of bean plants were sprayed at the rate of three pounds of 50 per cent spray powder per 100 gal., and beginning on the first day after spraying, six mature females were transferred to the leaves at intervals over a period of 45 days. These mites deposited eggs for five or six days and were then removed from the foliage. Seven to nine days later the plants were examined for hatched and unhatched eggs. The residue remained very toxic to the eggs for about 29 days, but its effectiveness fell rapidly after that period (Table IV).

2, 4-dichlorophenyl benzenesulphonate (Miticide 923).—50 per cent emulsifiable solution. General Chemicals, Allied Chemical and Dye Corporation, New York.

The residual action of this acaricide at a 1-400 dilution of the 50 per cent emulsifiable solution was comparatively poor; although a large number of immature mites were destroyed by residues up to 10 days old, mature females survived to deposit large quantities of eggs. These eggs gave rise to new mites, most of which were active on plants examined two weeks after being infested (Table V).

TABLE V
Residual Toxicity to the Two-spotted Spider Mite of 2,
4-dichlorophenyl benzenesulphonate, 50 per cent
Emulsifiable Solution, 1-400

Days between spraying and infesting	Total mites examined	Mortality after:	
		7 days	14 days
1	786	73.4	46.8
2	743	37.7	15.0
3	702	39.8	41.6
4	655	39.4	28.1
5	697	28.8	37.5
6	660	23.0	10.5
7	634	33.6	12.1
10	707	60.8	32.6
14	690	14.8	27.6
Check	672	3.4	2.6

Beta-chloroethyl-beta-(p-tert. butylphenoxy)-alpha-methyl ethyl sulphite (Aramite, 88R).—15 per cent wettable powder. Naugatuck Chemicals, Montreal, Que.

This acaricide has an effective residual action for approximately seven days. Since it has little or no ovicidal toxicity at the strength used, the eggs, laid in considerable numbers, gave rise to new mites, many of which were active when the seven-day records were made. At this time most of the original mite population had succumbed. The 14-day examinations showed that large percentages of newly hatched mites were destroyed on plants upon which the original mite populations had been introduced up to one week after the spray had been applied (Table VI).

Lauryl-2-thiazolinyl sulphide (IN-4200).—Emulsifiable solution containing 75 per cent mixed alkyl-2-thiazolinyl sulphides, chiefly lauryl. E. I. du Pont de Nemours and Co., Wilmington, Del.

Although the residual toxicity of a 1-800 dilution of the emulsifiable solution was not so pronounced as that of some acaricides tested, it was nevertheless high for six days after the spray had been applied. Some mature mites surviving the residual action deposited many eggs; on spray deposits six days old or less a few

failed to hatch, and many new mites from those that did hatch were destroyed (Table VII).

TABLE VI

Residual Toxicity to the Two-spotted Spider Mite of Beta-chloroethyl-beta-(p-tert. butylphenoxy)-alpha-methyl ethyl sulphite, 15 per cent Powder, 1.25 lb. per 100 gal.

Days between spraying and infesting	Total mites examined	Mortality after:	
		7 days	14 days
1	806	22.6	98.3
2	710	54.7	99.0
3	788	50.0	97.4
4	796	56.1	91.8
5	786	43.0	96.4
6	757	51.6	80.8
7	798	40.1	72.0
10	739	23.1	47.3
14	685	59.0	17.3
Check	738	3.7	5.4

TABLE VII

Residual Toxicity to the Two-spotted Spider Mite of Lauryl-2-thiazolinyl sulphide, 75 per cent Emulsifiable Solution, 1-800

Days between spraying and infesting	Total mites examined	Mortality after:	
		7 days	14 days
1	849	69.5	85.4
2	827	72.2	82.9
3	914	72.8	91.0
4	762	72.5	75.6
5	961	70.5	68.3
6	927	76.3	71.3
7	966	36.8	26.9
10	970	14.4	18.7
14	903	10.4	8.4
Check	864	2.6	4.0

Dinitro-o-cyclohexylphenol (DNOCHP) and its ammonium and monoethanolamine salts.—40 per cent wettable powder (DN Dry Mix No. 1). Dow

Chemical Corporation, Midland, Mich. The salts were prepared by adding excess of the respective bases to the powder in water.

Under the conditions of these experiments dinitro-o-cyclohexylphenol and its two salts showed residual toxicities that were not long-lasting, the exception being a strong spray at the rate of five ounces of DNOCHP (12.5 oz. DN Dry Mix No. 1) per 100 gal., which remained very effective for at least 10 days. The ammonium and monoethanolamine salts of DNOCHP at five ounces of the parent compound per 100 gal. were very effective for only the first three days, and then the toxicity dropped rapidly. At 2.5 oz., DNOCHP residual toxicities were much reduced, the salts again being much poorer than the parent compound (Table VIII).

TABLE VIII

Residual Toxicity to the Two-spotted Spider Mite of Dinitro-o-cyclohexylphenol and Its Ammonium and Monoethanolamine Salts

Materials per 100 gal.*	Days between spraying and infesting	Total mites examined	Mortality after:	
			7 days	14 days
DNOCHP 5 oz. (40% powder, 12.5 oz.)	1	1130	99.8	100.0
	3	1045	92.9	94.8
	7	1081	82.9	80.0
	10	1078	86.4	99.6
	14	1073	60.2	61.0
DNOCHP 2.5 oz. (40% powder, 6.25 oz.)	1	1157	89.8	72.6
	3	1082	59.0	70.2
	7	1189	38.3	32.4
	10	537	23.4	—
	14	524	10.7	—
Ammonium DNOCHP Actual DNOCHP, 5 oz.	1	1078	99.0	92.6
	3	1132	78.0	70.1
	7	1116	52.2	33.1
	10	530	37.9	—
	14	579	19.8	—
Ammonium DNOCHP Actual DNOCHP, 2.5 oz.	1	1119	81.7	26.7
	3	1178	34.3	25.2
	7	1083	8.8	16.3
	10	561	13.9	—
	14	526	14.5	—
Monoethanolamine DNOCHP Actual DNOCHP, 5 oz.	1	1166	87.7	89.6
	3	1053	79.6	69.8
	7	1059	11.9	40.0
	10	529	26.0	—
	14	557	14.5	—
Monoethanolamine DNOCHP Actual DNOCHP, 2.5 oz.	1	1080	58.3	21.2
	3	1109	20.7	11.6
	7	1050	10.2	10.3
	10	524	6.1	—
	14	515	8.3	—
DDT, 1 lb., alone	1	1061	2.9	3.2
	3	1100	4.0	5.7
	7	1153	3.9	14.0
	10	533	4.3	—
	14	537	6.5	—

* Each of these treatments contained one pound of DDT (actual).

Dinitro capryl phenyl crotonate (Arathane).—25 per cent wettable powder. Rohm and Haas Co., Inc., Philadelphia, Pa.

This acaricide at 0.5 lb. per 100 gal. (two pounds of 25 per cent powder) had good residual toxicity for five days, as determined from mortality records taken two weeks after the introduction of the mites. The seven-day mortality counts showed that the introduced mites were destroyed in considerable numbers for at least two weeks after spraying, but since this chemical appeared to work slowly, large quantities of eggs were deposited before the mites succumbed. These eggs hatched, and many young survived on plants infested six days or more after being sprayed (Table IX).

TABLE IX
Residual Toxicity to the Two-spotted Spider Mite of Dinitro capryl phenyl crotonate, 25% Powder, 2 Lb. per 100 Gal.

Days between spraying and infesting	Total mites examined	Mortality after:	
		7 days	14 days
1	851	94.3	90.2
2	920	92.0	94.4
3	958	94.4	84.8
4	895	85.8	71.9
5	864	91.2	77.3
6	891	88.0	37.3
7	870	77.3	24.0
10	842	69.6	34.3
14	848	87.1	52.1
Check	909	1.5	3.2

Parathion (Diethyl p-nitrophenyl thiophosphate).—15 per cent wettable powder. Other formulations from various sources were also tested on a limited scale.

Parathion is an outstanding acaricide, with a residual action persisting for six days when used at a rate of 0.3 lb. per 100 gal. (two pounds of 15 per cent spray powder) under greenhouse conditions. Most of the eggs deposited on the sprayed foliage hatched, but for about a week most of the new mites were destroyed. The lethal action of older residues was sharply reduced, especially after 14 days (Table X).

Various parathion formulations were found to differ in toxicity, especially residual toxicity, which was entirely lacking in some instances.

Ethyl p-nitrophenyl thionobenzene phosphonate (EPN).—31.5 per cent wettable powder. E. I. du Pont de Nemours and Co., Wilmington, Del.

The residual action of this acaricide, as determined from the greenhouse tests, was outstanding; no other acaricide so far tested, with the possible exception of 1, 1-bis-(p-chlorophenyl)ethanol, possesses such a long-lasting lethal action. For the first 12 days after spraying nearly 100 per cent of the introduced mites

TABLE X

Residual Toxicity to the Two-spotted Spider Mite of Parathion,
15 per cent Powder, 2 Lb. per 100 Gal.

Days between spraying and infesting	Total mites examined	Mortality after:	
		7 days	14 days
1	766	90.5	99.8
2	944	89.7	99.2
3	949	91.0	94.4
4	887	80.5	91.7
5	999	75.5	84.5
6	925	89.2	98.0
7	835	57.3	54.3
10	862	73.3	51.6
14	908	35.3	19.5
Check	817	1.9	4.1

TABLE XI

Residual Toxicity to the Two-spotted Spider Mite of Ethyl
p-nitrophenyl thionobenzene phosphonate, 31.5 per
cent Powder, 0.25 Lb. per 100 Gal.

Days between spraying and infesting	Total mites Examined	Mortality after:	
		7 days	14 days
1	767	98.6	100.0
2	815	99.4	100.0
3	774	96.4	100.0
4		93.0	100.0
5	845	96.1	99.8
6	780	87.5	100.0
7	799	90.9	99.7
10	844	88.2	100.0
12	743	93.5	98.9
14	1503	86.6	80.0
16	765	90.2	68.2
18	696	76.3	66.6
20	785	76.4	70.0
Check	1438	6.2	4.3

TABLE XII
Summary of Residual Toxicity of Acaricides to the Two-spotted Spider Mite; Mortalities 2 Weeks After Infestation.

Acaricides	Formulation	Pounds per 100 gal. or parts by volume	Percentage Mortality					
			Active ingredient	1 day	3 days	7 days	10 days	14 days
Ethyl p-nitrophenyl thiobenzene phosphonate (EPN), 31.5% powder.....	0.25 lb.	0.079 lb.		100.0	100.0	99.7	100.0	80.0
1,1-bis-(p-chlorophenyl) ethanol (DMC), 50% powder.....	0.5 lb.	0.25 lb.		99.9	100.0	86.0	99.5	89.4
P-chlorophenyl p-chlorobenzensulphonate (C-854), 50% powder.....	2.0 lb.	1.0 lb.		90.3	75.6	82.8	91.4	80.3
Dinitro-o-cyclohexylphenol (DNOCHP), 40% powder.....	0.78 lb.	0.31 lb.		100.0	94.8	80.0	99.6	61.0
Bis-(p-chlorophenoxy) methane (Neotran), 40% powder.....	2.5 lb.	1.0 lb.		86.9	85.4	93.3	55.0	15.7
Beta-chloroethyl-beta-(p-tert. butyphenoxy)-alpha-methyl ethyl sulphite (88R), 15% powder.....	1.25 lb.	0.188 lb.		98.3	97.4	72.0	47.0	17.3
Parathion, 15% powder.....	2.0 lb.	0.30 lb.		99.8	94.4	54.3	51.6	19.5
Dinitro capryl crotonate (Arathane), 25% powder.....	2.0 lb.	0.50 lb.		90.2	84.8	24.0	34.3	52.1
Lauryl-2-thiazolinyl sulphide (IN-4200), 75% emulsifiable solution.....	1.800	0.75 lb.		85.4	91.0	26.9	18.7	8.4
Dinitro-o-cyclohexylphenol (DNOCHP), 40% powder.....	0.39 lb.	0.16 lb.		72.6	70.2	32.0	23.4	10.7
Ammonium salt dinitro-o-cyclohexylphenol.....	0.78 lb.	0.31 lb.		92.6	70.1	33.0	37.9	19.8
Monoethanolamine salt dinitro-o-cyclohexylphenol.....	0.78 lb.	0.31 lb.		89.6	69.8	40.0	26.0	14.5
2,4-dichlorophenyl benzenesulphonate (923), 50% emulsifiable solution	1.400	1.0 lb.		46.8	41.6	12.1	32.6	27.6
Ammonium salt dinitro-o-cyclohexylphenol.....	0.39 lb.	0.16 lb.		26.7	25.2	16.3	13.9	14.5
Monoethanolamine salt dinitro-o-cyclohexylphenol.....	0.39 lb.	0.16 lb.		21.2	11.6	10.3	6.1	8.3

of all stages of development were destroyed when examined two weeks later, and a mortality of 70 per cent was produced by a deposit 20 days old (Table XI).

The mites appeared to be destroyed rapidly, for the mature females laid only a few eggs before succumbing. Most of the eggs hatched, but until the twelfth day after spraying the new mites were destroyed. After the fourteenth day some of the young survived.

Summary

In greenhouse tests of acaricides against the two-spotted spider mite, 1, 1-bis-(*p*-chlorophenyl) ethanol (DMC), ethyl *p*-nitrophenyl thionobenzene phosphonate (EPN), *p*-chlorophenyl *p*-chlorobenzenesulphonate (C-854), and dinitro-o-cyclohexylphenol (DNOCHP at five ounces per 100 gal.) were shown to have the most efficient toxicities, lasting for at least 14 days for the first three of these compounds and 10 days for the DNOCHP. A spray of DNOCHP at 2.5 oz. per 100 gal. was not nearly so effective. The residual action of beta-chloroethylbeta-(*p*-tert. butylphenoxy)-alpha-methyl ethyl sulphite (88R), and of bis-(*p*-chlorophenoxy)methane (Neotran) was effective for approximately seven days; para-thion, six days; dinitro capryl phenyl crotonate (Arathane), five days; and lauryl-2-thiazolinyl sulphide three to five days. The ammonium and monoethanolamine salts of DNOCHP possessed good residual toxicities for approximately three days when used at the five-ounce rate, but were of little value at 2.5 oz. 2, 4-dichlorophenyl benzenesulphonate (Miticide 923) showed very little residual action. Results are summarized in Table XII.

Acknowledgment

The author acknowledges with appreciation the invaluable help given by his colleague, William L. Putman, in the preparation of the manuscript.

The Kitto Insect Collection

An insect collection representing many Orders and numbering approximately 25,000 specimens, the property of the late W. Victor Kitto (see obituary notice, *Can. Ent.*, Vol. LXXXI, No. 12), has been presented to the Royal Ontario Museum of Zoology by the Misses Ethel and Mabel Kitto and Mr. F. Kitto.

During the past number of years, there has been a marked decrease in the number of amateur insect collectors of the calibre of the late Victor Kitto. It is most gratifying to receive a collection properly mounted and with each specimen bearing the necessary scientific data. Realizing the great contribution to the scientific study of insects that certain amateur collectors have made in the past, it is regrettable that we are witnessing the decline of such interest on the part of those not engaged in entomology professionally.

F. A. URQUHART, *Director*,
Royal Ontario Museum of Zoology.

International Great Plains Conference of Entomologists

The 23rd Annual Meeting of the International Great Plains Conference of Entomologists will be held at the Banff School of Fine Arts on August 31, September 1 and 2, 1950. Entomologists of the Field Crop and Livestock Insect Laboratories, Lethbridge, and the Department of Entomology, University of Alberta, Edmonton, are acting as joint hosts at this conference.

Aggregations of the Snow-flea, *Achorutes socialis* Uzel (Collembola), Recurring Over Three Years

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Aggregations of various species of spring-tails on the surface of the snow have been noted and reported upon by several authors. Of these species, the one occurring most commonly is *Achorutes socialis* Uzel (*Podura nivicola* Fitch) which Folsom (1916) records as being a common species in most parts of Europe and occurring in several localities in the north-eastern United States. MacNamara (1919b) studied the habits of this species as it appeared in the vicinity of Arnprior, Ontario, reporting that it "may be as thick as 500 to the square foot, while in hollows and depressions in the snow—such as foot-prints—from which they cannot escape, they sometimes accumulate in solid masses that could be ladled out with a spoon." James (1933) noted an assemblage of this species at Pottageville, Ontario, and reported that "beneath the hemlocks they covered the snow with a frequency of over 400 to the square foot." A related species, tentatively identified as *A. bengtsoni* Agren, appeared in a population estimated by Park (1949) as exceeding 4,000,000 from three exit holes in an area of six square feet in Illinois in December, 1946.

During March of the years 1948-50 a recurrence of a population of *Achorutes socialis* was noted by the writer on the snow covering a wooded ridge in a ravine adjacent to the campus of McMaster University, Hamilton, Ontario. The ridge is situated along the west border of the ravine leading from the campus to the Dundas Marsh which lies along the north-western limits of the city of Hamilton. The insects were first noted on March 14, 1948, when thousands were seen springing actively about on the snow. The ground beneath the snow was still frozen and the snow was two to six inches deep. Several specimens were preserved, some being sent to Dr. H. B. Mills of the Natural History Survey, Urbana, Illinois, who kindly identified them as *A. socialis*.

On March 20, 1949, the ridge was again examined and the snow-fleas were found to be present and in active movement. The ground was frozen and covered with one to five inches of snow. I paced off the ridge and found its dimensions to be 300 ft. x 60 ft., giving an area of 1800 square ft. Fourteen foot-square areas were measured off on the snow and the numbers of snow-fleas in them were counted. The average number of insects per square foot was 35, giving an estimated total of $35 \times 1800 = 63,000$ on the ridge. The insects tended to be most numerous around the bases of the trees.

On March 19, 1950, the ground on the ridge was frozen and covered with six inches of snow, the upper surface of which was damp, the day being sunny with a light wind. The snow-fleas were scattered sparsely about on the surface. Counts of the numbers of insects on eighteen foot-square areas were made and the average number per square was found to be 3, giving an estimated total population of $3 \times 1800 = 5,400$ insects on the ridge. The insects were most numerous around the bases of the trees and about stumps projecting through the snow. They appeared sluggish, many of them remaining in small pockets in the surface of the snow. Active ones infrequently jumped one or two inches. MacNamara (1919a) reports that *A. socialis* "easily springs four inches."

The appearance of *A. socialis* in the one area in March of three consecutive years indicates that a population of this species can inhabit a single habitat for several years. MacNamara (1919b) reports that "in six years' observation of their winter habits, I have never seen two large emergencies occurring in the same locality." He attributes this phenomenon to a great destruction of the

population as the insects make excursions onto the snow. In the aggregations of snow-fleas noted at Hamilton the greatest numbers of insects were found about bases of trees and around stumps where clear spaces led downward from the surface of the snow to the soil. These spaces probably formed the principal points of exit for the insects from the soil onto the snow.

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Notes on, and Additions to the Cerambycidae of Vancouver Island

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The following article contains two records apparently new to Vancouver Island, notes concerning two species rare in collections from the island and remarks concerning the status of *Leptura soror* LeConte.

Holopleura marginata LeC. A single male, taken on Mount Tzouhalem, Duncan, Vancouver Island, on May 21, 1947, by R. L. Fiddick apparently provides the first record for the island. This interesting species was called to my attention by G. Stace Smith of Creston to whom it was originally sent for determination. The only other British Columbia record, published by H. B. Leech (1945) is based on a single specimen beaten from a Douglas fir at Arrowhead, B.C. by G. Slade on May 10, 1945.

This species was described by LeConte in 1873 from California. I have no knowledge of its occurrence in intermediate localities. How such a noticeable species has hitherto escaped detection in this province is a mystery unless it has only recently been accidentally introduced. More records are needed to determine its true status in the province.

Anoplodera bebbrensi (LeC.) One female taken at Tofino, Vancouver Island, on July 30, 1947, by Kenneth Gibson apparently provides the first record for Vancouver Island. I am again obliged to G. Stace Smith for drawing my attention to the existence of this species, and to Richard Guppy of Wellington, B.C., for kindly loaning the specimen for my inspection. While several records are available for the mainland of British Columbia it does not appear to be common anywhere. It was described by LeConte in 1837 from specimens collected in Northern California (loc. cit.). It has been taken in Oregon and Washington, while Smith informs me that he has collected it in Quebec. A second specimen was taken on Vancouver Island by R. Guppy near Wellington on July 30, 1948.

Poliaenus oregonus (LeC.) Until recently no Vancouver Island records for this species were known to me since 1902. One was taken "at light" in Victoria on May 25, 1947 by E. G. Harvey of the Forest Insect Investigations, Dominion Department of Agriculture, Victoria, B.C.

In the larval stage this species feeds in *Abies grandis*. While specimens have been taken frequently on the mainland it seems extraordinary that more

have not been taken on the island during this long interval, despite much intensive search.

Phymatodes lecontei Linsley (= *obscurus* LeC.). This species, hitherto considered rare on Vancouver Island, was found in large numbers by Dr. C. B. Conway in the basement of his residence in Victoria, B.C. during the month of July, 1947. On July 29th a visit to the locality yielded over a score of dead and living specimens in the space of 5 minutes; while an additional 30 living ones were caught that same evening. At this date the peak of their abundance had passed and it was apparent that the statement that they had occurred "in hundreds" was no exaggeration.

A fortuitous combination of favourable conditions seems to be responsible for their discovery. *P. lecontei* feeds in the larval stage in Garry Oak (*Quercus Garryana*), the life cycle covering a period of about 12 months. The basement had been filled with the wood of this tree since the winter of 1945-46, much of it being covered with sawdust, so that the long period of equable temperature and moisture was evidently suited to the habits of this species.

By nature the adult shuns the daylight, disappearing under loose bark or other cover if accidentally exposed.

It is most active at dusk and after dark, when it is readily attracted to artificial light; it was at this time they made their presence so obvious, swarming over and into everything within range, including running down the back of one's neck, in their efforts to find a hiding place.

Phymatodes lecontei was first recorded by the writer for Vancouver Island (and B.C.) in 1927 as *P. obscurus* LeC., and up to the present only about a couple of dozen specimens have been reported. Evidently its habits are such that while apparently more common than at first suspected its appearance rarely coincides with that of its would-be collectors.

Leptura soror (LeC.) Several specimens of this species were taken in the Jordan Meadow area in August 1947, on flowers of *Achellia millefolium* but no specimens of *L. oblitterata* were obtained. Swaine and Hopping (1928) regard *soror* as a colour phase of *oblitterata* basing their contention on their experience on the mainland where males of *soror* were taken mating with females of *oblitterata*. These authors place *L. soror* as a synonym of *L. oblitterata*.

My experience with these beetles on Vancouver Island does not confirm these inter-relationships. While both forms are often found together no cross mating has ever been observed, though repeatedly watched for. *L. soror* appears to be more addicted to the higher and moister forested areas and is considerably less common than *oblitterata*.

Even if it should be proved by genitalia and life history studies that they are one and the same species, it seems desirable to retain the name *soror* as a ready means of distinguishing such a marked colour form. In the meantime I prefer to regard *soror* and *oblitterata* as distinct species insofar as field observations on Vancouver Island are any indication.

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Book Reviews

A Century of Entomology in the Pacific Northwest, by Melville H. Hatch,
University of Washington Press, Seattle, 1949. v + 43 pp.; 9 illust. \$1.50.

This little volume was developed from material accumulated and presented as an invitation paper at the 28th annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists at Oregon State College, Corvallis, June 16, 1943. It was read again at the 43rd annual meeting of the Entomological Society of British Columbia at Vancouver, a meeting which the reviewer was fortunate enough to attend, and at which the interest and appreciation shown by the members was indicative of the timeliness of the topic and the adequacy of its treatment. Dr. Hatch traces the history of entomological endeavour, amateur and professional, in the rich area of the Pacific Northwest, i.e., British Columbia, Washington, Idaho, and Oregon.

Himself a resident and ardent entomological student of the region concerned, Dr. Hatch was ideally suited by experience and temperament to undertake the presentation of this delightful little history. In an interesting manner, and supported by a number of well chosen portraits of early notables in the field, he traces the entomological history of the Pacific Northwest through a period of itinerant collectors, a period of resident collectors, the period of established laboratories, from 1890-1930, and finally the period from 1930 to the present.

The period of itinerant collectors commenced in 1834, with Dr. J. K. Townsend, and terminated roughly in the middle seventies. The earliest collectors were general naturalists, accompanying various exploring expeditions, and collected insects only incidentally. This is well shown by the fact that the names of such men as Townsend, Peale, Suckley, Cooper, Gibbs, and Lord are perhaps better known in the fields of ornithology, mammalogy, and botany than they are in entomology, and occur rather frequently in the specific or racial names of birds, mammals, or plants peculiar to the region. Thomas, Walsingham, Crotch, and Morrison, collecting in the seventies, were entomologists in a stricter sense. The beetles, perhaps, received more attention than did other orders in these early years, and the younger LeConte published the first reports on the insects of the region.

The period of resident collectors is traced from the middle seventies to the early nineties. The pioneers were O. B. Johnson of Oregon and Washington, and the Rev. G. W. Taylor of Vancouver Island. Also included were Danby of Victoria, Keen of Queen Charlotte Islands, and Trevor Kincaid, who commenced his long career by energetic collecting during the period under consideration. Many new species were described by Eastern specialists on the basis of material provided by Kincaid.

The period of established laboratories commenced between 1888 and 1893 with the establishment of Agricultural Experiment stations in the Northwestern States, with Washburn in Oregon, Piper in Washington, and Aldrich in Idaho. Simultaneously, in British Columbia, the Provincial Government commenced issuing reports which contained sections on injurious insects. Hutcherson was the first inspector of fruit pests. The Dominion Entomological service commenced in British Columbia in 1911, at Agassiz, with R. C. Treherne. The Entomological Society of British Columbia, the first such society of the region, was founded in 1902.

The development of entomological training at the universities is traced, and short notes are given on the instructors, their careers, and more notable works. The same is done with the amateurs of the period, and with government entomologists of the United States and Canada concerned with the economic problems

of the region. Some of the key figures receive special consideration in the text. Included are photographic studies of J. M. Aldrich, A. L. Melander, G. W. Taylor, R. C. Treherne, A. L. Lovett, E. M. Blackmore, R. Hopping, O. B. Johnson, and Trevor Kincaid.

The contemporary period, 1930 to the present, is briefly covered, but again, adequately, the numerous workers and their contributions to the knowledge of the fauna being well summarized.

Though primarily concerned with the history of the personalities engaged in entomological studies, and the listing of their works, Hatch does give some brief consideration to the nature of the insect species of this most interesting region, and the part played by an irregular topography in affecting geographical distribution. Being a coleopterist, his examples are, not surprisingly, drawn from the beetles. Short notes on introduced pests, too, are provided, with first recorded dates.

The volume terminates with a short chapter on the major insect collections in the region, and bibliography of pertinent literature, about 250 titles being listed. A taxonomic index summarizes the work by orders, and includes references to papers on arthropods other than insects.

This volume contains an astonishing amount of information condensed in a very small space. Attractively bound, and well printed, it deserves a place on the shelf of any entomologist interested in that rich and varied region known as the Pacific Northwest.

G. P. HOLLAND

Insects Affecting Forest Products and Other Materials, by W. J. Chamberlin.
Oregon State College Co-operative Association, Corvallis Ore. 1949. Lithographed. ix + 159 pp.

This book is "a consideration of the damage inflicted by insects and their near relatives to timber and timber products, both raw and finished, in storage or in final placement, together with a brief discussion of similar damage to metals and concrete". It embodies the author's long experiences with forest insects in the Pacific Northwest, and much information from the available literature. It is designed as a classroom and field guide for forestry students, particularly those interested in wood utilization.

After an introductory discussion of the losses caused by insects of forest products, the author describes briefly the insects, their near relatives: their morphology, metamorphosis, and biology. He also presents a synopsis of types of damage to wood products and the agents responsible. He devotes a whole chapter to termites: their life-histories and castes, materials attacked, control methods, protective treatments, resistant woods, and a sample of pest control legislation. Chapter III deals with wood-boring Lepidoptera. A chapter is devoted to each of the three major groups of wood-boring Coleoptera: Buprestidae, Cerambycidae, and Scolytoidea. Another chapter treats of various families of lesser importance. Those families which commonly attack seasoned wood, including the 'powder post beetle' group, are treated in Chapter VIII. The next two chapters cover the wood-boring Hymenoptera: the horntails, the wood-boring sawflies and bees, and the carpenter ants; and the cambium-mining Diptera, whose larval activities result in visible defects in solid wood. The final two chapters are devoted to a discussion of insects recorded as attacking metal (usually lead cables), and of marine borers (not insects) affecting wooden piling and cement-concrete.

In these chapters, the principal species are described briefly. Life-histories, hosts, type of injury, economic importance, and control recommendations are discussed at varying length. A summary is given of treatment methods which have been used for protection against borers in logs, posts, and poles. Also included is a synoptic key to the more important families of beetles that may cause defects in timber. The primary breakdown in this key is made on the basis of host material and type of injury, but the final division is on the basis of adult characters. The author has included numerous drawings and photographs of various species and the work of some of the more important ones. References are included in each chapter, and at the end is a select bibliography of the Coleoptera injurious to forest products. Although at first confusing, the unorthodox chronological listing of references aids in choosing the more recent works on a particular subject.

The reviewer questions the wisdom of including certain admittedly unimportant species or groups (found only in rotting wood) at the expense of others left out or too briefly treated. No mention is made of members of the genera *Goes* Lec. and *Romaleum* White (Cerambycidae) that attack living oaks and hickories and cause defects which appear commonly in sawn lumber or cooperage stock. *Neoclytus caprea* (Say) is an important pest of felled ash logs, yet no control recommendations are offered. In the same family there is some outdated nomenclatorial usage, as well as inconsistencies such as the use of *Megacyllene* Csy. for the locust borer and the pre-occupied *Cyllene* Newn. for the congeneric painted hickory borer. Although synonymous in recent lists, *Neoclytus acuminatus* (Fab.) and *N. erythrocephalus* (Fab.) are listed separately. Concerning dipterous larvae the author makes the following generalization: "The eyes and mouth are usually lacking; food is assimilated osmotically through the skin". This statement spans the gap between truth and absurdity in two short jumps. The omission from the bibliographies of a recent comprehensive bulletin (1946) on eastern Scolytides (*Scolytoidea of North Carolina*. Duke Forest Bull. No. 10) is regrettable. A number of illustrations (flat even at best by the litho process), which the author has borrowed from other sources, have a checkered effect because of the double reproduction by the half-tone screen process. There is, of course, the usual quota of typographical errors, some of them unfortunate.

This book contains a wealth of information. With guidance or prior knowledge to steer him past the pitfalls, the student should find it valuable, particularly in conjunction with the study of known samples of damage by the various species. The bibliographies are useful stepping-stones to further study of any particular group. All forestry students, particularly those majoring in wood technology and utilization, should be familiar with the book. Forest and general entomologists, particularly coleopterists, should find it enlightening. Mill men untrained in entomology might find it interesting, though of little practical use. The approach from the viewpoint of damage to timber and wood products is commendable, but is perhaps not carried far enough.

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Obituary

FRANCIS J. A. MORRIS (1869-1949)

In the death of Francis J. A. Morris Canada has lost a great teacher of English literature, a classical scholar, a writer of charm, in both prose and verse, and a naturalist of distinction. After a lingering illness of some years' duration he died on December 31st, 1949.

Until he was twenty-five years old Frank Morris lived in the British Isles. He was born in 1869 in a parsonage near the Scottish town of Crieff in Perthshire, where he remained until the death of his father, when Frank was thirteen years of age. It was during these boyhood years in Scotland that the foundations of his later interests were laid. He was fascinated by the beauty of all the living things about him. Flowers were his first interest, then, with the companionship of his brother, he became engrossed in birds and birds' nesting, in the rearing of moths and butterflies, and finally in insects generally which, for a few years the brothers collected with avidity.

After the death of their father the boys were moved to London, where they suffered a partial separation by attending different schools, but still carried on their hobbies together. Frank attended Dulwich College, where he became immersed in the Classics and English Literature, reading widely, particularly Nineteenth Century poetry and the novels of the day. The brothers continued to spend their free time together, adding to their collection of insects and, under the guidance of a new school friend, making long excursions into the countryside. Their friend's favourite hobby was fossil collecting and to this new pastime he introduced the Morris brothers, taking them out to the chalk pits near Croydon, where they spent many hours digging out fossils from the chalk beds, and delighting in the many new kinds of birds and insects of the downs.

The brothers still spent their holidays together in their old haunts in Scotland, but when Frank was sixteen his brother set sail for Australia and Frank was thrown on his own resources. School studies claimed most of his time and the boyish interest in collecting waned, although his delight in the contemplation of living nature grew even more intense.

His outlook on nature, however, soon began to be coloured by a rapidly growing interest in Darwinism and the theory of Evolution, which he had often heard discussed at school, although his interest in the subject was not seriously aroused until it was expounded to him by an old army doctor, who was generally the boys' host on their trips to Scotland, and who was a scholar and an ardent disciple of Darwin.

At Oxford University Morris continued to pursue the Classics but varied his reading with many works on Evolution. In spite of this new interest, however, his emotional attitude towards nature not only persisted but was kindled afresh by his discovery that in Wordsworth's poetry was an expression of all his own feelings and sentiments concerning nature.

Soon after graduating from Oxford Morris came out to Canada, spending his first winter in Toronto in attendance at the Normal School. It was in Toronto that he first met Dr. William Brodie to whom he owed his introduction to Canadian natural history. Dr. Brodie remained a close friend to Morris until his death in 1909, which was commemorated by Morris in his poem "The Master Mind".

After a summer in Toronto, Morris was appointed to the staff of the High School at Smiths Falls and here he learned from the science master how to identify plants with a "key", for he had never felt the need of scientific methods

before, as there were plenty of popular guides to the British flowers and birds. This new skill became a veritable obsession to him. He was never tired of adding to his acquaintance with the local flora so that, by the end of the second year, when he left Smiths Falls, he knew most of the commoner flowering plants of the region.

At this time he accepted a private tutorship in the neighbouring town of Perth, and it happened that his pupil was an ardent ornithologist. A close friendship grew up between tutor and pupil of the give-and-take kind and the teacher learned much from the pupil about Ontario birds and their songs and calls.

In 1899 Morris returned to Toronto for the spring and summer. He again had the companionship of Dr. Brodie and enjoyed the opportunity of adding to his acquaintance with the Ontario flora. In the following April he had settled in Port Hope where he had been appointed Classical Master in Trinity College School. His first two seasons here were spent in active pursuit of botany and ornithology. For a time his attention was mainly concentrated on bird watching, but he also gave much of his free time to those pupils who were interested in natural history, particularly in competing for a prize that was offered annually for the best collection of "flowers, foliage and ferns". These boys organized a Field Club, with Morris as their Honorary President.

One April morning a deputation from the Club came to Morris' room to ask if insects could be accepted as a subject for the prize competition. After some consideration Morris agreed to this, but limited the field to moths and butterflies or beetles. Beetles having been chosen by some of the boys, the difficulty of naming them at once became a major problem, and thus Morris was besieged with enquiries morning, noon and night. Beetles had as yet no special place in Morris' hobbies and there was no "Beetle Book" like Holland's *Butterfly Book* and *Moth Book*. So, out of sheer desperation, Morris began to make a collection of beetles for himself and, with the help of various texts, he was soon a beetle addict in an advanced stage. This interest in beetles, particularly the long-horns, became a permanent one and is reflected in a number of delightful essays that appeared in *The Canadian Entomologist* and the Annual Reports of the Entomological Society of Ontario. He served as President of this Society in 1921-1923.

In order to qualify as a Specialist in Classics, Morris attended the University of Toronto and obtained the degree of Master of Arts. In September, 1913, he was appointed to the staff of the Peterborough Collegiate Institute where he taught Classics for a time. Further study at the University of Toronto enabled him to become the head of the English Department in the Peterborough Collegiate Institute, a position which he retained until his retirement in 1936.

It was not long after Morris was settled in Peterborough that he chanced to meet Edward A. Eames of Buffalo, whose hobby was the photography of wild orchids. These were also favourites of Morris and it was not long before the two enthusiasts had planned to collaborate in a book for the amateur naturalist on "Our Wild Orchids", the text to be written by Morris and the illustrations furnished by Eames. A most beautiful book was the outcome, a literary gem in which the incidents recorded about each species are set forth in fine prose with those touches of gentle humour that are a part of the charm of all Morris' writings. Many happy years were spent by the "foursome", consisting of the two authors and their wives, in gathering material for this venture and, even after the book was published, Morris continued to find his greatest delight in tracking down and recording of rare and little-known orchids.

In addition to his writings on Natural History, which included also the widely circulated Federation of Ontario Naturalist's booklet on the Protection of Wild Flowers, Morris contributed articles to *The Canadian Forum* and various other magazines in Canada and the United States. Most of his verse is unpublished but two poems "The First Hepatica" and "Life" are included in Professor Alexander's "Shorter Poems", which has been used for a whole generation in the Ontario High Schools. His love for the Victorian poets is clearly revealed in his own verse.

Any account of Frank Morris' life, however brief, would be inadequate without paying a high tribute to his wife (nee Elma Walker), whom he married while he was living in Port Hope. Even before the long years of his final illness she ministered faithfully and cheerfully to all his needs, for he was, as related by himself, somewhat awkward with his hands, his fingers being "all thumbs". The writer recalls a week spent with the Morrises at Silver Islet, Lake Superior, when he observed with admiration how Mrs. Morris would drive the car to any spot which her husband wished to explore, and would cheerfully wait for hours, if need be, until his return. It was a most fortunate thing for him that he had such a wife to care for him during the years of his decline. To this gracious lady we extend our deepest sympathy.

E. M. WALKER

